

**26th International Technical
Meeting of the Satellite Division of
the Institute of Navigation**

(ION GNSS 2013)

Nashville, Tennessee, USA
16-20 September 2013

Volume 1 of 4

ISBN: 978-1-62993-578-2

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2013) by the Institute of Navigation
All rights reserved.

Printed by Curran Associates, Inc. (2014)

For permission requests, please contact the Institute of Navigation
at the address below.

Institute of Navigation
8551 Rixlew Lane
Suite 360
Manassas, VA 20109

Phone: (703) 366-2723
Fax: (703) 366-2724

membership@ion.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

ION® GNSS 2013 Proceedings

Table of Contents

Viewing of the text and graphics and the ease of readability will depend on the quality and/or consistency of the author original file.

PLENARY SESSION

Challenges of Globally Implementing ADS-B (Automatic Dependent Surveillance – Broadcast): Martin-Ulrich Ripple, <i>UberDash Consulting Pty Ltd., Canada</i>	1
Defining the Gold Standard for Navigation: Logan Scott, <i>LS Consulting</i>	16

A1: Remote Sensing with GNSS and Integrated Systems

GNSS Reflected Signal Acquisition with Galileo Signals: T.R. Peres, R. Castro, J.S. Silva, N. Catarino, P.F. Silva, <i>DEIMOS Engenharia, Portugal</i>	38
--	----

Enhancing Gyrocompassing Performance Using Low-Cost Optical Sensors: M.J. Veth, <i>Veth Research Associates, LLC</i>	47
---	----

Remote Sensing of Soil Based on a Compact and Fully Software GNSS-R Receiver: Y. Pei, R. Notarpietro, S. De Mattia, P. Savi, F. Dovis, <i>Politecnico di Torino, Italy; M. Pini, Istituto Superiore Mario Boella, Italy</i>	56
---	----

Snow Height and Surface Temperature Variations from Ground GPS Receivers in Greenland: N. Najibi, S. Jin, <i>Shanghai Astronomical Observatory, Chinese Academy of Sciences, China</i>	62
--	----

GPS Seismo-ionospheric Disturbances and Behaviors Following the 2011 Tohoku and 2008 Venchuan Earthquakes: S. Jin, R. Jin, <i>Shanghai Astronomical Observatory, Chinese Academy of Sciences, China</i>	69
--	----

On the Correlation Between Ionosphere Scintillation and Geomagnetic Field Activity: Y. Jiao, Y. Morton, S. Taylor, <i>Miami University (Ohio); W. Pelgrum, Ohio University</i>	77
--	----

Distributed Array of GPS Receivers for 3D Wind Profile Determination in Wind Farms: D. Chen, L. Heng, D. Jia, G.X. Gao, <i>University of Illinois at Urbana-Champaign</i>	84
---	----

B1: Receiver/Antenna Technology

Using Both GPS L1 C/A and L1C: Strategies to Improve Acquisition Sensitivity: K.C. Seals, <i>U.S. Coast Guard Academy</i> ; W.R. Michalson, <i>Worcester Polytechnic Institute</i> ; P.F. Swaszek, <i>University of Rhode Island</i> ; R.J. Hartnett, <i>U.S. Coast Guard Academy</i>	92
Analysis and Verification to the Effects of NH Code for BeiDou Signal Acquisition and Tracking: K. Yan, H. Zhang, T. Zhang, L. Xu, X. Niu, <i>Wuhan University, China</i>	107
Integrating Compression and Multi-Rate Algorithms for Robust Acquisition: Analysis using GPS L2C Signal: S.R. Babu, A. Kumar, V. Gambhir, <i>Samsung Research India Limited, India</i>	114
Improving GNSS Bit Synchronization and Decoding Using Vector Tracking: T. Ren, M. Petovello, <i>University of Calgary, Canada</i> ; C. Basnayake, <i>General Motors</i>	121
Collaborative GNSS Signal Processing: A. Soloviev, <i>Qunav</i> ; J. Dickman, <i>Northrop Grumman</i>	135
A Novel Approach for Multipath and Interference Mitigation with Dual Tracking Antenna Receiver: P. Ramaoli, M. Puccitelli, S. Fantinato, L. Siniscalco, G. Guarino, <i>Thales Alenia Space Italia S.p.A., Italy</i> ; R. Guidi, V. Martorelli, <i>Ingegneria dei Sistemi S.p.A.</i> ; D. Jiménez Baños, J.A. Ávila Rodríguez, <i>European Space Agency, The Netherlands</i>	144
GNSS Multipath Mitigation using High-Frequency Antenna Motion: T. Ertan, M.L. Psiaki, B.W. O'Hanlon, R.A. Merluzzi, S.P. Powell, <i>Cornell University</i>	154
Quad Constellation Receiver- GPS, GLONASS, Galileo, BeiDou: P.G. Mattos, <i>STMicroelectronics, UK</i> ; F. Pisoni, <i>STMicroelectronics, Italy</i>	176
Matched Quantization and Band Separation in a Direct Sampling Dual Band GNSS Receiver for Civil Aviation: A. Blais, C. Macabiau, O. Julien, <i>École Nationale de l'Aviation Civile, France</i>	182
GNSS Receiver Technology Trends: J-H. Won, S-J. Ko, I. Kraemer, <i>University FAF Munich, Germany</i>	197

C1: Aviation Applications

SBAS Flight Trials in European Eastern Countries where EGNOS is Still not Available: J. Cegarra, J. Escartín, J. Ostolaza, <i>GMVAD, Spain</i> ; M. Krywanis-Brzostowska, <i>European GNSS Agency</i> ; H. de With, <i>GNSS Expert</i>	205
Assessment of Alternative Positioning Solution Architectures for Dual Frequency Multi-Constellation GNSS/SBAS: G.A. McGraw, B.A. Schnaufer, P.Y. Hwang, M.J. Armatys, <i>Rockwell Collins</i>	223
Can Current DME Support PBN Operations with Integrity?: G.E. Berz, V. Vitan, I. Skyrda, <i>Eurocontrol, Belgium</i> ; P.B. Ober, <i>Integricom, The Netherlands</i>	233

The Future Role of a “Standalone” Distance Measuring Equipment (DME) in the United States National Airspace System (NAS): E. Etienne, V. Hinton, S. Fodge, <i>Federal Aviation Administration</i> ; R. Achanta, <i>Tetra Tech</i>	251
A Testbed for Studying Automatic Dependent Surveillance Broadcast (ADS-B) Based Range and Positioning Performance to Support Alternative Position Navigation and Timing (APNT): Y-H. Chen, S. Lo, <i>Stanford University</i> ; D.M. Akos, <i>University of Colorado at Boulder</i> ; G. Wong, P. Enge, <i>Stanford University</i>	263
Wide Area Multilateration Evaluation Test Bed using USRP Based ADS-B Receiver: S-S. Jan, S-L. Jheng, A-L. Tao, <i>National Cheng Kung University, Taiwan</i>	274
Real-Time Data Link Implementation Aspects of a Measurement-Based ADS-B System for Conflict Detection and Resolution: P. Duan, M. Uijt de Haag, <i>Ohio University</i> ; J.L. Farrell, <i>Vigil Inc.</i>	282
Precise GNSS Product-Aided Flight Inspection System: Y. Wang, <i>Queensland University of Technology, Australia</i> ; X. Shi, <i>Beihang University, China</i> ; P. Wang, <i>Aviation Data Communication Corporation, China</i>	292
The EGNOS NOTAM Proposals Service: Towards Full ICAO Compliance: J. Vázquez, M.A. Sánchez, <i>ESSP-SAS, Spain</i> ; J. Cegarra, P.D. Tejera, P. Gómez Martínez, <i>GMVAD, Spain</i>	301
GNSS Multipath Failures Modes Analysis for Airport Surface Operations: L. Montloin, L. Azoulai, <i>Airbus, France</i> ; A. Martineau, C. Milner, C. Macabiau, <i>ENAC Telecom lab, France</i>	316
Curved Approach Segments for Noise Abatement: M. Troller, R. Germann, <i>Skyguide, Swiss Air Navigation Services, Switzerland</i> ; A. Frik, <i>Cessna Aircraft Company, Zurich Citation Service Center, Switzerland</i> ; M. Bertschi, <i>Swiss Air Force, Switzerland</i> ; P. Truffer, M. Scaramuzza, <i>Skyguide, Swiss Air Navigation Services, Switzerland</i>	333
D1: Emerging GNSS (Galileo, COMPASS, QZSS, IRNSS)	
An Efficient Acquisition Method for the CSK Signal of QZSS LEX: K. Nakakuki, R. Hirokawa, <i>Mitsubishi Electric Corporation Kamakura Works, Japan</i>	340
BeiDou Receiver Autonomous Integrity Monitoring (RAIM) Performance Analysis: X-L. Su, <i>Shanghai Jiao Tong University, China/ China Academy of Engineering Physics, China</i> ; X. Zhan, F. Qin, X. Zhang, Y. Zhang, <i>Shanghai Jiao Tong University, China</i>	348
Design, Implementation, and Performance Analysis of ACE-BOC Modulation: Z. Yao, M. Lu, <i>Tsinghua University, China</i>	361
The Comparison on the Positioning Performance Between BeiDou and GPS: Y. Xu, S. Ji, W. Chen, D. Weng, Y. Xu, W. Chen, D. Weng, <i>The Hong Kong Polytechnic University, Hong Kong</i> ; S. Ji, <i>China University of Petroleum, China</i>	369
Four-constellation Reliability in Challenging GNSS Signal Environments and the Estimation of Inter-system Time-offsets: R. Winit, K. O’Keefe, <i>University of Calgary, Canada</i>	383
BeiDou Consumer Receiver Chips at Last: P.G. Mattos, <i>STMicroelectronics, UK</i> ; F. Pisoni, <i>STMicroelectronics, Italy</i>	398

Approaches to Obtaining BeiDou Hazardous Pseudorange Bias with the Ordered Weighted Aggregation Operators: S. Qian, *Research Center of Electrical Automation and Information Communication, China Waterborne Transport Research Institute, China*; Y. Yuan, *China Air Force Engineering University, China* ----- 403

E1: Indoor Navigation and Timing 1

Analysis and Testing of Optimal Navigation Message Rate for IMES: S. Pullen, *Stanford University*; D. Manandhar, H. Torimoto, *GNSS Technologies, Inc., Japan* ----- 408

WLAN TOA Ranging with GNSS Hybrid System for Indoor Navigation: B. Li, K. O'Keefe, *University of Calgary, Canada* ----- 416

Positioning in GPS Challenged Locations – The NextNav Terrestrial Positioning Constellation: S. Meiyappan, A. Raghupathy, G. Pattabiraman, *NextNav, LLC*. ----- 426

Seamless Location Based Services (LBS) in Train Stations Using GNSS and IMES: A. Shikimura, *Hokkaido JR Cybernet Co., Ltd., Japan*; K. Mutoh, *Japan Aerospace Exploration Agency, Japan*; N. Kohtake, *Keio University, Japan*; M. Utsumi, *Generation Create, Japan*; T. Furutou, *East Japan Marketing & Communications Inc., Japan*; H. Tomita, *Hitachi, Ltd., Japan*; M. Ishii, *GNSS Technology Inc., Japan* ----- 432

The GEOCOM Mobile Positioning System: D. Weigand, E. Soto, M. Volpe, J. Koss, *The Boeing Company* ----- 439

Truck Roll Constraint to Improve Heading Estimation in Pedestrian Dead Reckoning Navigation Systems: T. Jakel, D. Gebre-Egziabher, *University of Minnesota, Twin Cities* ----- 448

Visual Positioning with Image Database and Range Camera: W-W. Kao, I-J. Chu, *National Taiwan University of Science and Technology, Taiwan* ----- 461

Using Multiple Sensor Triads for Enhancing the Navigation Solution of Portable and Wearable Devices: M. Omr, *Trusted Positioning Inc./Queen's University, Canada*; J. Georgy, *Trusted Positioning Inc., Canada*; A. Noureldin, *Royal Military College of Canada/Queen's University, Canada* ----- 467

F1: Alternatives and Backups to GNSS 1

LTE OTDOA Positioning Performance Under Interference Conditions: T-Y. Chiou, Y-W. Ting, Y-C. Lin, *MediaTek Inc, Taiwan* ----- 473

Optimization of Tracking Loops for Signals of Opportunity in Mobile Fading Environments: C. Yang, *Sigtem Technology, Inc.*; T. Nguyen, *Air Force Research Lab/RYWN* ----- 479

Novel Environmental Features for Robust Multisensor Navigation: D. Walter, P.D. Groves, *University College London, UK*; B. Mason, J. Harrison, J. Woodward, P. Wright, *TerraFix Ltd., UK* ----- 488

Vision-based Real-time Estimation of Smartphone Heading and Misalignment: B. Kazemipur, Trusted Positioning Inc./University of Calgary, Canada; Z. Syed, J. Georgy, Trusted Positioning Inc., Canada; N. El-Sheimy, University of Calgary, Canada -----	505
Stereo-Vision Aided GNSS for Automotive Navigation in Challenging Environments: B.M. Aumayer, M.G. Petovello, G. Lachapelle, University of Calgary, Canada -----	511
Instantaneous Ambiguity Resolution of MOSAIC/DME: A Single Station Based 3D Positioning System for Alternative PNT: O-J. Kim, C. Kim, J. Song, Y. Kim, C. Kee, Seoul National University, South Korea --	521
Nav-by-Search: Exploiting Geo-referenced Image Databases for Absolute Position Updates: L. Hamilton, P. Lommel, <i>The Charles Stark Draper Laboratory</i> ; T. Galvin, <i>Massachusetts Institute of Technology</i> ; J. Jacob, P. DeBitetto, M. Mitchell, <i>The Charles Stark Draper Laboratory</i> -----	529

Panel 1: Program Updates

GPS Program Updates: B. Cooley, <i>GPS Directorate</i> -----	537
Galileo Programme Status Update: E. Chatre, <i>European Commission, Belgium</i> -----	555
Quasi-Zenith Satellite System Current Status: Y. Murai, <i>QZS System Service Inc., Japan</i> -----	580

A2: Marine and Land Based Applications

Demonstrating the Benefits of Resilient PNT: A. Grant, P. Williams, C. Hargreaves, M. Bransby, <i>The General Lighthouse Authorities of the United Kingdom and Ireland</i> -----	598
SeaSlug: A Low-cost, Long-duration Mobile Marine Sensor Platform for Flexible Data-collection Deployments: B. Mairs, R. Curry, G. Elkaim, <i>University of California, Santa Cruz</i> -----	605
Networked GPS Approach to Tracking Marine Animal Schools: L. Heng, G.X. Gao, <i>University of Illinois at Urbana Champaign</i> -----	612
At-sea Data Collection in the Salmon Fisheries Using GPS-enabled Android: J.W. Lavrakas, W. Black, <i>Advanced Research Corporation</i> -----	620
A PVT Estimation for the ERTMS Train Control Systems in Presence of Multiple Tracks: A. Neri, A.M. Vegni, <i>RADIOLABS, Italy</i> ; F. Rispoli, <i>Ansaldo STS, Italy</i> -----	631
Cooperative GNSS Signal Processing Algorithms for Intelligent Transport Systems: R. Bauernfeind, D. Dötterböck, E. Gkougkas, B. Eissfeller, <i>University FAF Munich, Germany</i> -----	645
Experimental Evaluation for Road User Charging of GPS/GLONASS/MEMS OBU: M. Azola, C. Moriana, P. Navarro, D. Valdés, L. Bonardi, M. Toledo, J. Cosmen, <i>GMV, Spain</i> -----	656

Automated Estimation and Mitigation of Wireless Time-Delays in Smartphones for a Robust Integrated Navigation Solution: Y. Zhuang, <i>University of Calgary / Trusted Positioning Inc., Canada</i> ; Z. Syed, C. Goodall, U. Iqbal, <i>Trusted Positioning Inc., Canada</i> ; N. El-Sheimy, <i>University of Calgary / Trusted Positioning Inc. Canada</i> -----	667
Pushing Standardisation of GNSS-based Location Systems to Support Terrestrial Applications Development: J. Giraud, <i>Thales Alenia Space, France</i> ; M-L. Mathieu, <i>FDC, France</i> ; J.P. Boyero Garrido, I. Fernandez Hernandez, <i>European Commission</i> -----	677

The Performance Analysis of a Portable Mobile Mapping System with Different GNSS Processing Strategies: C-H. Chu, K-W. Chiang, C-A. Lin, <i>National Cheng-Kung University, Taiwan</i> -----	689
On-Line Visual Driver Aid for Safe and Precise Convoy Following in Visibility-Impaired Conditions: R. Cofield, S. Martin, D. Bevly, <i>Auburn University</i> -----	704

B2: Alternatives and Backups to GNSS 2

Distance Measuring Equipment Accuracy Performance Today and for Future Alternative Position Navigation and Timing (APNT): S. Lo, Y.H. Chen, P. Enge, B. Peterson, <i>Stanford University</i> ; R. Erikson, <i>Federal Aviation Administration</i> -----	711
Impact of Ground Multipath on Terrestrial Radio Navigation Performance: K. Li, W. Pelgrum, A. Naab-Levy, <i>Ohio University</i> -----	722
CHAMELEON v2: Improved Imaging-inertial Indoor Navigation: J. Rydell, E. Emilsson, <i>Swedish Defence Research Agency, Sweden</i> -----	737
GPS Denied Navigation Using Meta-Image Objects From Georeferenced Maps: B.A. Schnaufer, <i>Rockwell Collins</i> ; K. Celik, <i>Iowa State University</i> ; J. Nadke, P. Hwang, <i>Rockwell Collins</i> ; A. Somani, <i>Iowa State University</i> -----	746

Experimental Study of Two-channel UWB-OFDM Radar for Indoor Navigation with INS Integration: K. Kauffman, J. Raquet, <i>Air Force Institute of Technology</i> ; Y. Morton, D. Garmatyuk, <i>Miami University (Ohio)</i> -----	756
--	-----

Integrating Vision Derived Bearing Measurements with Differential GPS and UWB Ranges for Vehicle-to-vehicle Relative Navigation: E.A. Abolfathi, K. O'Keefe, <i>University of Calgary, Canada</i> -----	762
Positioning Results for LDACS1 Based Navigation with Measurement Data: N. Schneckenburger, B. Elwischger, D. Shutin, M. Suess, B. Belabbas, M-S. Circiu, <i>German Aerospace Center (DLR), Germany</i> -----	772

Integration of Vision and Navigation: J.E Kain, J. Summerville, <i>WaldoAir Corporation</i> -----	782
Research on the Epoch Folding Phase Estimation X-ray Pulsars Relative Navigation Based Spatial States Determination of Formation Flying Spacecrafts: C-J. Guo, Z. Tian, X-C. Zhang, <i>University of Electronic Science and Technology of China</i> ; Z. Chen, <i>China Aerospace Science and Industry Academy of Information Technology, China</i> -----	792

C2: GNSS Space Based Augmentation Systems (SBAS)

SBAS L1/L5 ICDS and Alternatives: Analysis of Multi-GNSS Service Performance Assessment:

M. Cueto, A. Cezón, J. Caro, *GMV, Spain*; C. Rodriguez, D. Brocard, *ESA/ CNES, France*; J.C. Denis, *ESA*; E. Châtre, *European Commission, Belgium* ----- 805

Implementation of the L5 SBAS MOPS: T. Walter, J. Blanch, P. Enge, *Stanford University* ----- 814

Qualifying an L5 SBAS MOPS Ephemeris Message to Support Multiple Orbit Classes:

T. Reid, T. Walter, P. Enge, *Stanford University* ----- 825

SBAS Interoperability Demonstration: F. Lorge, *Federal Aviation Administration* ----- 844

Receiver Inter System Bias Impact on SBAS Dual Constellation Positioning and Integrity:

C. Boulanger, N. Suard, F. Mercier, C. Rodriguez, *CNES, France*; D. Lapeyre, *Thales Services, France* ----- 854

A New Method to Make Ionospheric Delay Corrections in SBAS for GPS and Compass Dual

Constellations: S. Wang, B. Zhu, *Peking University, China* ----- 865

SBAS in Equatorial Regions: A. Cezón, M. Cueto, E. Sardón, D. Rizzo, *GMV, Spain* ----- 875

The Arctic Testbed – Providing GNSS Services in the Arctic Region: P.E. Kvam, *Kongsberg Seatex, Norway*; M. Jeannot, *European Space Agency* -----

----- 890

WAAS Availability Over the Solar Maximum: T. Schempp, B. Stimmmer, *Raytheon Company* ----- 902

Dual Frequency SBAS Trial and Preliminary Results for East-Asia Region: T. Sakai, K. Hoshinoo, *Electronic Navigation Research Institute, Japan*; T. Walter, *Stanford University* ----- 912

Enhanced SBAS with Satellite Dynamic Mask and Precise Orbit and Clock Corrections: J. Caro,

J. Barrios, V.M. Esteban, V. Izquierdo, A. Madrazo, M. Odriozola, J. Ostolaza, J. Simon, *GMV, Spain* ----- 921

D2: GPS and GLONASS Modernization

GPS III Signal Integrity Improvements: S. Shaw, A.J. Katronick, *Lockheed Martin Corporation* ----- 936

Economic Benefits of Using Industry-sector Monitoring Systems Based on GNSS: A. Dorofeeva, *JSC*

"Navigation-Information Systems," Russia ----- 946

GPS Inter-Signal Corrections (ISCs) Study: W. Feess, J. Cox, E. Howard, K. Kovach, *The Aerospace*

Corporation ----- 951

GPS SPS Performance in 2012 – How Good Was It?: B. Renfro, J. Kammerman, M. Bratton, D. Munton,

ARL, The University of Texas at Austin ----- 959

GLONASS Navigation Message Format for Flexible Row Structure: A.A. Povalyaev, *JSC Russian Space*

Systems Moscow Aviation Institute (National Research University), Russia ----- 972

E2: Indoor Navigation and Timing 2

- Next Generation Indoor Positioning System Based on WiFi Time of Flight:** L. Banin, U. Shtzberg, Y. Amizur, *Intel Corp, Israel* ----- 975
- Accurate Indoor Positioning Using Multipath Components:** C. Gentner, T. Jost, A. Dammann, *German Aerospace Center (DLR), Germany* ----- 983
- User Aided Self-growing Approach on Radio Map Construction for WLAN Based Localization:** D. Zou, W. Meng, S. Han, Z. Gong, *Harbin Institute of Technology, China*; B. Yu, *Hebei Satellite Navigation Technology and Equipment Engineering Technology Research Centre, China* ----- 991
- High-Accuracy Indoor Navigation Utilizing RF Wireless Location Signatures and High-Fidelity Predictive Models:** J.J. Zhu, D. Qiu, J. Blaha, D.S. De Lorenzo, T. Bhattacharya, *Polaris Wireless* ----- 998
- SmartSLAM - An Efficient Smartphone Indoor Positioning System Exploiting Machine Learning and Opportunistic Sensing:** R.M. Faragher, R.K. Harle, *University of Cambridge, UK* ----- 1006
- Imaging Sensors for Optical Wireless Location Technology:** A. Arafa, X. Jin, D. Guerrero, R. Klukas, J.F. Holzman, *University of British Columbia, Canada* ----- 1020
- Cooperative Exploitation for Indoor Geolocation:** A. Soloviev, *Qunav, LLC*; C. Yang, *Sigtem Technology, Inc.* ----- 1024
- Indoor Localization Based on Magnetic Anomalies and Pedestrian Dead Reckoning:** J. Ma, J. Qian, P. Li, R. Ying, P. Liu, *Shanghai Jiaotong University, China* ----- 1033

F2: GNSS-MEMS Integration

- Context Detection, Categorization and Connectivity for Advanced Adaptive Integrated Navigation:** P.D. Groves, H. Martin, K. Voutsis, D. Walter, L. Wang, *University College London, UK* ----- 1039
- Investigating the use of MEMS Based Wrist-worn IMU for Pedestrian Navigation Application:** J. Qian, J. Ma, L. Xu, R. Ying, W. Yu, P. Liu, *Shanghai Jiao Tong University, China* ----- 1057
- Low Power Tracking of GNSS Signal by IMU Aided Intermittent Tracking Algorithm:** L. Xu, M. Wang, R. Ying, P. Liu, W. Yu, *Shanghai Jiao Tong University, China* ----- 1065
- Development of High-precision Navigation Algorithm by Fusion of GPS and MEMS Sensors:** Y. Kosaka, T. Tsuchiya, *The University of Tokyo, Japan*; M. Naruoka, H. Tomita, *Japan Aerospace Exploration Agency (JAXA), Japan*; H. Kurihara, K. Ishida, T. Ichikawa, *Tokyo Aircraft Instrument Co. Ltd., Japan* ----- 1071
- MEMS Sensor Assisted Terrestrial Vehicular Navigation on Portable Devices:** S. Bharadwaj, S. Murali, J. Balakrishnan, *Texas Instruments, India*; A. Deshpande, *University of Wisconsin, USA*; Y. Shekar, *Texas Instruments, India*; G. Dutta, *AngioMetrix Corporation, India* ----- 1084

An Algorithm for Automatic Inertial Sensors Calibration: S. Guerrier, R. Molinari, <i>University of Geneva, Switzerland</i> ; J. Skaloud, <i>École Polytechnique Fédérale de Lausanne, Switzerland</i> ; M-P. Victoria-Feser, <i>University of Geneva, Switzerland</i>	1092
---	------

A Technique for Fast Magnetometer Calibration with Little Space Coverage: A. Wahdan, J. Georgy, W.F. Abdelfatah, A. Noureldin, <i>Trusted Positioning Inc, Canada</i>	1098
--	------

Panel 2: IP Policies Related to GNSS

U.S. Position Regarding GPS/GNSS Civil Signal Intellectual Property:

D.A. Turner, <i>U.S. Department of State</i>	1105
--	------

Towards an IP Policy for the EU GNSS Programme Galileo:

G. Caratti, <i>European Commission, JRC, Belgium</i>	1120
--	------

IP Landscape, Risks and Policies Around GNSS: Pascal Asselot, <i>France Brevets, France</i>	1143
--	------

A3: Precise Point Positioning

Real Time Precise GPS Constellation and Clocks Estimation by Means of a Kalman Filter:

D. Laurichesse, L. Cerri, J.P. Berthias, F. Mercier, <i>Centre National d'Etudes Spatiales, France</i>	1155
--	------

Integrity Monitoring in Precise Point Positioning: G. Seepersad, S. Bisnath, <i>York University, Canada</i>	1164
--	------

Precise Point Positioning with Fast Ambiguity Resolution - Prerequisites, Algorithms and Performance:

L. Mervart, C. Rocken, T. Iwabuchi, Z. Lukes, <i>GPS Solutions Inc., USA</i> ; M. Kanzaki, <i>Hitachi Zosen Corp., Japan</i>	1176
--	------

Concepts for Undifferenced GLONASS Ambiguity Resolution:

S. Banville, <i>Natural Resources Canada & University of New Brunswick, Canada</i> ; P. Collins, F. Lahaye, <i>Natural Resources Canada, Canada</i>	1186
---	------

Interchangeable Integration of GPS and Galileo by Using a Common System Clock in PPP:

T. Melgard, <i>Fugro Satellite Positioning AS, Norway/University of Calgary, Canada</i> ; J. Tegedor, <i>Norwegian University of Life Sciences As, Norway</i> ; K. de Jong, <i>Fugro Intersite BV, The Netherlands</i> ; D. Lapucha, <i>Fugro Chance Inc., USA</i> ; G. Lachapelle, <i>University of Calgary, Canada</i>	1198
--	------

Time Correlation in GNSS Precise Point Positioning: M.E.D. Goode, S.J. Edwards, P. Moore, <i>Newcastle University, UK</i> ; K. de Jong, <i>Fugro Intersite B.V., The Netherlands</i>	1207
---	------

Towards the Inclusion of Galileo and BeiDou/Compass Satellites in Trimble CenterPoint RTX:

H. Landau, M. Brandl, X. Chen, R. Drescher, M. Glocker, A. Nardo, M. Nitschke, D. Salazar, U. Weinbach, F. Zhang, <i>Trimble TerraSat GmbH, Germany</i>	1215
---	------

Improving Ambiguity Validation and Integrity Monitoring of Precise Point Positioning (PPP):
A. Jokinen, S. Feng, W. Schuster, W. Ochieng, *Imperial College London, UK*; L. Yang, T. Moore,
C. Hill, *NGI, University of Nottingham, UK* -----1224

An Evaluation of Solar Radiation Pressure Models for QZS-1 Precise Orbit Determination:
S. Ikari, T. Ebinuma, R. Funase, S. Nakasuka, *The University of Tokyo, Japan* -----1234

B3: Multi-Sensor and Integrated Navigation in GNSS-Challenged Environments 1

Performance of Fault Detection and Exclusion for GNSS/Locata Integrated Navigation:
L. Yang, *University of New South Wales, Australia* -----1242

Seamless Indoor Outdoor Positioning using Bayesian Sensor Data Fusion on Mobile and Embedded Devices: G. Hejc, J. Seitz, J. Gutierrez Boronat, T. Vaupel, *Fraunhofer Institute for Integrated Circuits, IIS, Germany* -----1252

Error Correction Method with Precise Map Data for GPS/DR Based on Vision/Vehicle Speed Sensor:
B-H. Lee, G-I. Jee, *Konkuk University, Republic of Korea*; S-H. Im, M-B. Heo, *Korea Aerospace Research Institute, Republic of Korea* -----1260

Probabilistic Integration of 3D Building Models and GNSS for Reliable Vehicle Localization in Urban Areas—the GAIN Approach: S. Bauer, M. Obst, G. Wanielik, *Chemnitz University of Technology, Germany* -----1267

Ultra-Wideband Aided Carrier Phase Ambiguity Resolution in Real-Time Kinematic GPS Relative Positioning: E. Broshears, S. Martin, D. Bevly, *Auburn University* -----1277

Tightly Coupled Multi-GNSS Receiver Fusion for Robust Position Estimation in Urban Environments:
R. Streiter, S. Bauer, G. Wanielik, *Technische Universität Chemnitz, Germany* -----1285

Real-time Cycle-slip Detection and Correction for Land Vehicle Navigation using Inertial Aiding:
M.O. Karaim, T.B. Karamat, *Queen's University, Canada*; A. Noureldin, *Royal Military College of Canada and Queen's University, Canada*; M. Tamazin, *Queen's University, Canada*; M.M. Atia, *Royal Military College of Canada* -----1290

Reliability of GNSS Measurements via Pseudorange Prediction Using an Odometer for Robust Land-Vehicle Navigation: K.A. Bin Ahmad, M. Sahmoudi, *ISAE, France*; C. Macabiau, *ENAC, France* -----1299

Comparison of Tightly Coupled and Deeply Coupled GPS/INS Integration for Automotive Application Using a Software Defined GNSS Receiver Framework: M. Langer, G.F. Trommer, *Karlsruhe Institute of Technology, Germany* -----1308

Wi-Fi Indoor Localisation Based on Collaborative Ranging Between Mobile Users:
H Jing, J. Pinchin, C. Hill, T. Moore, *University of Nottingham, UK* -----1317

GPS-Aided Lane Marking Detection and Vehicle Positioning: E. Broshears, *Auburn University* -----1325

C3: GNSS Ground Based Augmentation Systems (GBAS)

Tightening DGNSS Protection Levels Using Direct Position-Domain Bounding:

O. Osechas, J. Rife, *Tufts University* -----1329

An Empirical Model for Computing GPS SPS Pseudorange Natural Biases Based on High Fidelity

Measurements from a Software Receiver: S. Gunawardena, F. van Graas, *Ohio University* -----1341

Simulation of Swept FM Interference and its Impact on an Aviation Receiver:

M. Brenner, *Honeywell* -----1359

Performance Analysis and Experimental Validation of Broadband Interference Mitigation Using an Atomic Clock-Aided GPS Receiver: F-C. Chan, M. Joerger, S. Khanafseh, B. Pervan,

Illinois Institute of Technology; O. Jakubov, Nottingham Scientific Ltd. -----1371

GPS Multipath Assessment in Real Airport Conditions to Support Category III Operations:

L. Azoulai, A. Chen, Y. Cruz Cavalcanti, *Airbus, France* -----1380

GAST C and GAST D Performance Analysis Based on BeiDou Navigation Satellite System:

Z. Wang, J. Zhang, Y. Zhu, R. Xue, *Beihang University, China* -----1395

Potential for the use of GBAS at Close-by Airports: M. Felux, P. Remi, S. Circiu,

German Aerospace Center (DLR), Germany -----1403

Design of Ephemeris Fault Detection Algorithm Using Baseline Length of Integrated GBAS: J. Ahn,

D. Won, S. Sung, Y.J. Lee, *Konkuk University, Republic of Korea; J. Kim, Korea Aerospace University, Republic of Korea; H.S. Jun, Korea Aerospace Research Institute, Republic of Korea* -----1411

GBAS Enhancement by Using the Ionospheric Gradient Correction: D. Weng, W. Chen, S. Ji, Y. Xu,

The Hong Kong Polytechnic University, Hong Kong -----1417

Detecting Ionospheric Threat for GBAS Based on Spatial-temporal Method: P. Zhao, J. Zhang,

R. Xue, *Beihang University, China* -----1428

D3: GNSS Compatibility, Interoperability, and Services

The Inadequacy of the Spectral Separation Coefficient and Aggregate Gain Factor for Quantifying the

Effects of GPS C/A Code Self Interference: A.J. Van Dierendonck, *AJ Systems; R.J. Erlandson, Federal*

Aviation Administration Consultant, K. Shallberg, S. Ericson, Zeta Associates, Inc. -----1435

On the Design of a GNSS Acquisition Aiding Signal: M. Paonni, M. Bavaro, *Institute for the Protection and*

Security of the Citizen (IPSC), Joint Research Centre (JRC) European Commission, Italy -----1445

Galileo Consumer Receiver: Live Satellites at Last: P.G. Mattos, *STMicroelectronics, UK;*

F. Pisoni, STMicroelectronics, Italy -----1457

Analysis of the use of CSK for Future GNSS Signals: A. Garcia-Pena, D. Salos, O. Julien,

Ecole Nationale de L'Aviation Civile (ENAC), France; L. Ries, T. Grelier, Centre National d'estudes

Spatiales (CNES), France -----1461

First GNSS Positioning using IOV Galileo Satellites: B. Bonhoure, C. Boulanger, T. Chapuis, F.X. Marmet, N. Suard, *CNES Centre National d'Etudes Spatiales, France* -----1480

E3: Software Receivers

Turning a Television into a GNSS Receiver: C. Fernández-Prades, J. Arribas, P. Closas, *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain* -----1492

Open Source Software Defined Radio Platform for GNSS Recording and Simulation:
A. Brown, J. Redd, M. Dix, *NAVSYS Corporation* -----1508

Fast Prototyping of Receiver Accelerators Using NI LabVIEW FPGA: A. Soghoyan, *University of Texas at San Antonio*; D. Kinjarapu, *Qualcomm, Inc.*; D. Akopian, *University of Texas at San Antonio* -----1517

Feasibility Study on the use of Xilinx COTS Rad-Hardened FPGAs to for GNSS Signal Acquisition in Space Applications: S. Ramakrishnan, P. Enge, *Stanford University* -----1527

A Software Defined Radio Solution for Hybrid GPS/Signals of Opportunity Navigation:
M.B. Mathews, P.F. MacDoran, *Loctrонix® Corporation* -----1539

STARx – A GPU Based Multi-System Full-Band Real-Time GNSS Software Receiver:
B. Huang, Z. Yao, F. Guo, S. Deng, X. Cui, M. Lu, *Tsinghua University, China* -----1549

A Universal GNSS Software Receiver MATLAB® Toolbox for Education and Research:
S. Gunawardena, *Ohio University* -----1560

A Multiple Lock Detector for the Signal Abnormality Detection in the GPS Receiver: M.H. Jin, Y.S. Choi, H.H. Choi, S.J. Lee, *Chungnam National University, Republic of Korea*; C. Park, *Chungbuk National University, Republic of Korea* -----1577

F3: Urban Navigation Technology

Correcting GNSS Multipath Errors Using a 3D Surface Model and Particle Filter:
T. Suzuki, N. Kubo, *Tokyo University of Marine Science and Technology, Japan* -----1583

Multipath Mitigation Methods Based on Diversity Algorithms: S. Rougerie, *AUSY, France*; G. Carrie, *Thales Alenia Space, France*; J. Israel, *ONERA, France*; L. Ries, *CNES, France*; M. Monnerat, *Thales Alenia Space, France*; P. Thevenon, *ENAC, France* -----1596

Urban Positioning on a Smartphone: Real-time Shadow Matching Using GNSS and 3D City Models:
L. Wang, P.D. Groves, M.K. Ziebart, *University College London, UK* -----1606

Pulsed-RF Ultra Wideband Transceivers for Aiding in Distributed Navigation Networks:
B. Dewberry, *Time Domain* -----1620

Heading Misalignment Estimation Between Portable Devices and Pedestrians:
A. Ali, H-W. Chang, J. Georgy, Z. Syed, C. Goodall, *Trusted Positioning Inc., Canada* -----1626

TAXISAT: A Driverless GNSS Based Taxi Application Capable of Operating Cost Effectively: O. Otaegui, <i>Vicomtech-IK4, Spain</i> ; O. Desenfans, V. Barreau, <i>M3Systems, Belgium</i> ; L. Plault, <i>Capital HighTech, France</i> ; A. Lago, <i>Robosoft, France</i>	1634
Navigation Performance Using Long-Term Ephemeris Extension for Mobile Device: Y. Li, Y. Gao, <i>University of Calgary, Canada</i>	1642
Varying Step Length Estimation Using Nonlinear System Identification: A. Wahdan, M. Omr, J. Georgy, A. Noureldin, <i>Trusted Positioning Inc., Canada</i>	1652
Methods for Improving PPP Accuracy in Urban Canyons: Y. Kubo, Y. Suzuki, M. Ozaki, M. Ohashi, S. Sugimoto, <i>Ritsumeikan University, Japan</i>	1659
Omni-directional Antenna Model Based Wi-Fi Positioning Method for Urban Area: J-H. Song, G-I. Jee, <i>Konkuk University, Republic of Korea</i>	1665
Simulating Non-LOS GNSS Reflected Signals in Urban and Dense Urban Environments: J. Jakobsen, <i>DTU Space, National Space Institute, Denmark</i> ; A.B.O. Jensen, <i>AJ Geomatics, Denmark</i>	1670

Panel 3: New Products

GNSS Road Applications: Y. Capelle, <i>GUIDE – Thales Alenia Space France</i>	1675
Location for Mobile Computing: G. Turetzky, <i>Intel Mobile Communications</i>	1688
New Developments in Mobile Devices Chips and Receivers for GNSS: P.G. Mattos, <i>STMicroelectronics R&D Ltd, UK</i>	1702
GNSS and ITS: The Need for Performance Standards: F. Peyret, <i>IFSTTAR, France</i>	1717
Galileo “Early Services” Promoting New Applications and Products: M. Lisi, <i>European Space Agency/European Commission/European GNSS Agency, The Netherlands</i>	1731
Uninhabited Aerial Vehicle as Avionics Prototyping Platforms: D. Gebre-Egziabher, <i>University of Minnesota</i>	1748
Symmetricom Generates, Distributes and Applies Precise Time: P. Bourekas, <i>Symmetricom</i>	1765
Pgy 'Rt qf wew'RcpgrlF kiewuIqp: S. Hickling, <i>Spirent</i>	1767
Train Control Systems with GNSS Capability: Market Trends and Challenges: F. Rispoli, <i>Ansaldo STS, Italy</i>	1778
Modernized Military GPS User Equipment: Our Way Forward: T. Sharpe, <i>The Aerospace Corporation</i>	1786

A4: GNSS and the Atmosphere 1

Determination of GPS Tropospheric Delays by Utilizing Ground-based GPS Network Measurements and its Applications for Weather Forecasts and Precise Point Positioning: D. Kim, K-D. Park, <i>Inha University, Republic of Korea</i>	1795
--	------

Performance Analysis of Pseudolite Tropospheric Delay Models Using Meteorological Radiosonde with Flight Test Results: H. So, K. Lee, Y. Park, J. Park, K. Song, <i>Agency for Defense Development, Republic of Korea</i>	1802
Scintillation Characterization for WAAS During Solar Maximum: E. Altshuler, <i>Sequoia Research Corporation</i> ; K. Shallberg, <i>Zeta Associates Incorporated</i> ; B.J. Potter, <i>LS Technologies</i>	1810
A New Triple-frequency, Ionosphere-free Technique for Ambiguity Resolution of Long-range Baseline: Y. Xu, S. Ji, W. Chen, D. Weng, Y. Xu, W. Chen, D. Weng, <i>The Hong Kong Polytechnic University, Hong Kong</i> ; S. Ji, <i>China University of Petroleum, China</i>	1823
Quantitative Spectrum Analysis on High Latitude and Equatorial Ionosphere Scintillation: J. Wang, Y. Morton, Q. Zhou, <i>Miami University (Ohio)</i> ; W. Pelgrum, <i>Ohio University</i>	1833
Prediction of Regional Ionospheric Delays with Spherical Cap Harmonic Analysis and Vector Auto-Regressive Models: M. Ohashi, K. Nishimoto, T. Sakai, Y. Kubo, S. Sugimoto, <i>Ritsumeikan University, Japan</i>	1840
Mitigation of Ionospheric Mapping Function Error: M.M. Hoque, N. Jakowski, <i>German Aerospace Center (DLR), Germany</i>	1848
Ionosphere Magnetic Storm Occurrence Probability: M. Chassan, <i>IMT Université Toulouse 3 & CNES, France</i> ; J-M. Azaïs, <i>IMT Université Toulouse 3, France</i> ; G. Buscarlet, <i>Thales Alenia Space, France</i> ; N. Suard, <i>CNES, France</i>	1856
Small-scale Ionospheric Delay Variation Associated with Plasma Bubbles Studied with GNSS and Optical Measurements and its Impact on GBAS: S. Saito, T. Yoshihara, <i>Electronic Navigation Research Institute, Japan</i> ; Y. Otsuka, <i>Nagoya University, Japan</i>	1869
Ionosphere TEC and TEC Gradients Estimation Using a Regional GNSS Network: C. Wang, <i>Tongji University, China</i> and <i>Miami University (Ohio)</i> ; Y. Morton, <i>Miami University, (Ohio)</i>	1875
B4: GNSS Simulation and Testing	
Evaluation of GNSS RF Signal Simulators and Receivers Based on Recorded Multi GNSS Signals in Scenarios of Traffic Telematics: R. Richter, <i>Technische Universität Dresden, Germany</i> ; B. Wolf, <i>Fraunhofer Institute for Transportation and Infrastructure Systems IVI, Germany</i> ; O. Michler, <i>Technische Universität Dresden, Germany</i>	1881
Real-Time Utilization of IGS Stations in SPEED: F. Dufour, <i>Centre National d'Etudes Spatiales (CNES), France</i> ; P. Larhantec, J.A. Gicquel, S. Boher, <i>Thales Alenia Space France (TAS-F), France</i>	1890
Navigation Enabler for Single Satellite Vehicle: J. Hsu, R.T. Bow, T. Tam, <i>The Aerospace Corporation</i> ; P.A. Toth, <i>LinQuest Corporation</i>	1897
Recording and Replay of GNSS RF Signals for Multiple Constellations and Frequency Bands: S. Hickling, <i>Spirent Communications Ltd., UK</i> ; T. Haddrell, <i>Integrated Navigation Systems Ltd., UK</i>	1907

Automated Test-bench Infrastructure for GNSS Receivers – Case Study of the TUTGNSS Receiver:
S. Thombre, J. Raasakka, T. Paakki, F. Della Rosa, M. Valkama, J. Nurmi, *Tampere University of Technology, Finland* -----1919

GNSS Over-the-Air Testing using Wave Field Synthesis: A. Rügamer, G. Del Galdo,
Fraunhofer Institute for Integrated Circuits IIS, Germany; J. Mahr, *Technical University Ilmenau, Germany*; G. Rohmer, G. Siegert, M. Landmann, *Fraunhofer IIS, Germany* -----1931

A-GPS Assistance Network Delay Modeling and Estimation Over Mobile Networks:
G. Huang, D. Akopian, *The University of Texas at San Antonio* -----1944

An Integrated and Cost-Effective Simulation Tool for GNSS Space Receiver Algorithms Development:
J.S. Silva, H.D. Lopes, T.R. Peres, J.M. Vasconcelos, M.M. Coimbra, P.F. Silva, *DEIMOS Engenharia, Portugal*; P. Palomo, J. Pérez, J.A. Pulido, *DEIMOS Space, Spain*; A. Garcia, J. Roselló, *European Space Agency* -----1951

C4: Algorithms and Methods

Receding Horizon Trajectory Optimization for Simultaneous Signal Landscape Mapping and Receiver Localization: Z.M. Kassas, J.A. Bhatti, T.E. Humphreys, *University of Texas at Austin* -----1962

Plug-and-play Information Fusion in an INS/GNSS/SoOps Integrated Navigation:
X. Zhang, X. Zhan, *Shanghai Jiao Tong University, China* -----1970

Overcoming Errors in Processing Nonlinear Measurements: A New Extension for the Kalman Filter:
A. Draganov, *Argon St, a whole owned subsidiary of the Boeing Company* -----1977

Effects of Non-Gaussian and Non-White Noise Processes on Image-Based Targeting for Mission-Critical Applications: M.J. Veth, *Veth Research Associates, LLC* -----1988

An Innovative and Efficient Frequency Estimation Method for GNSS Signals Acquisition:
P. Esteves, *Institut Supérieur de l'Aéronautique et de l'Espace (ISAE/SUPAERO), TeSA, University of Toulouse, France* -----1996

Multipath Mitigation Using Linear Adaptive Filtering Techniques: S. Ugazio, L. Lo Presti, *Politecnico di Torino, Italy*; E. Falletti, *Istituto Superiore Mario Boella, Italy* -----2007

Attitude Determination with Low-cost GPS/INS: P. Henkel, *Technical University of Munich and Advanced Navigation Solutions – ANAVS, Germany*; C. Günther, *Technical University of Munich; Advanced Navigation Solutions – ANAVS, and German Aerospace Center (DLR), Germany* -----2015

A New Multipath Detection and Mitigation Approach for Pseudolite Systems:
O. Kurz, C. Mongredien, G. Rohmer, *Fraunhofer Institute for Integrated Circuits IIS, Germany* -----2024

Climbing the GNSS Hill: Lessons from the Evolution of the GPSTk: B. Parsons, J. Little, B. Tolman, B. Renfro, S. Nelsen, D. Munton, *ARL, The University of Texas at Austin*; B. Harris, *MAE, The University of Texas at Arlington* -----2032

D4: Multi-Sensor and Integrated Navigation in GNSS-Challenged Environments 2

Autonomous Snowplow Design: S. Craig, A. Naab-Levy, K. Li, R. Kollar, P. Duan, W. Pelgrum, F. van Graas, M. Uijt de Haag, *Ohio University* -----2044

Robust Wi-Fi Assisted GNSS Positioning in Urban Canyons: S. Ramakrishnan, D.W. Waters, J. Balakrishnan, *Texas Instruments, India* -----2058

Novel Integrity Monitoring for Train Navigation using a GNSS-IMU Bayesian Position Estimator and a Curvature Change Detector: B. Belabbas, A. Grosch, *German Aerospace Center (DLR), Germany* -----2066

Reconfigurable Integration Filter Engine (RIFE) for Plug-and-Play Navigation: A. Soloviev, *Qunav, LLC*; C. Yang, *Sigtem Technology, Inc.* -----2075

Relative Navigation with Displacement Measurements and its Absolute Correction: C. Yang, *Sigtem Technology, Inc.*; A. Soloviev, *Qunav, LLC* -----2084

SIGIL: A Novel GNSS/INS Integration for Challenging Environment: J-B. Lacambre, M-L. Duplaquet, J-M. Louge, Y. Paturel, *iXBlue, France*; R. Deurloo, F. Boon, K. Smolders, B. Bougard, *Septentrio Satellite Navigation, Belgium* -----2094

Detection and Mitigation of Errors on an Ultra-Tight Integration System Based on Integrity Monitoring Method: F. Qin, X. Zhan, X-L. X. Zhang, *Shanghai Jiao Tong University, China* -----2102

A Low-cost Integrated Navigation System of Quadrotor Aerial Vehicle: Design, Development and Performance: Z. Zhou, J. Zhang, J. Bai, *University of Electronic Science Technology of China, China*; L. Yang, *University of New South Wales, Australia* -----2114

E4: Advanced Inertial Sensing and Applications

A New Approach to Better Low-cost MEMS IMU Performance Using Sensor Arrays: H. Martin, P.D. Groves, *University College London, UK*; M. Newman, *BAE Systems, UK*; R. Faragher, *University of Cambridge, UK* -----2125

Attitude Determination Kalman Filter with 1/f Flicker Noise Gyro Model: M.E. Pittelkau, *Aerospace Control Systems, LLC* -----2143

Nuclear Magnetic Resonance Gyroscope: For DARPA's Micro-Technology for Positioning, Navigation and Timing Program: M. Larsen, M. Bulatowicz, *Northrop Grumman* -----2161

Thermal Analysis and Temperature Control Strategy for FOG-Based SINS: L. Fu, C. Duan, *Beihang University, China* -----2166

The Effects of Using Heading Measurement During Alignment of a Low-cost IMU/GPS System:
M. Choi, Konkuk University, Republic of Korea; D. Won, University of Colorado, USA; S. Sung, Konkuk University, Republic of Korea; Y. Lee, Korea Advanced Institute of Science and Technology, Republic of Korea; J. Kim, Korea Aerospace University, Republic of Korea; J-P. Park H-W. Park, Agency for Defense Development, Republic of Korea; Y.J. Lee, Konkuk University, Republic of Korea -----2175

Railway Track Irregularity Measuring by GNSS/INS Integration: Q. Chen, Q. Zhang, Y. Cheng, Wuhan University, China -----2180

Sensor Auto-Calibration on Dynamic Platforms in 3D: J. Britt, D.M. Bevly, Auburn University -----2195

The Development of a FOG Based Tightly Coupled GNSS/INS Integrated System with Simple Temperature Compensation Method for Land Applications: J-K. Liao, T-T. Duong, K-W. Chiang, T-H. Kuo, National Cheng Kung University, Taiwan -----2204

Robustness Evaluation and Improvements of an In-situ Hand Calibration Method for Low-end IMUs in Pedestrian Navigation Applications: Y. Li, X. Niu, Q. Wang, C. Shi, Wuhan University, China -----2213

F4: New Products and Commercial Services

Performances and Applications using TERRASTAR® Precise Point Positioning Service:
J. Van Hees, L. LeThuaut, P. Nemry, Septentrio Satellite Navigation, Belgium -----2221

Description and Applications of EDAS (EGNOS Data Access Service): E. Lacarra, J. Vázquez, ESSP-SAS, Spain; A.J. Gavín, J. Morán, GMV, Spain; M.A. Sánchez, ESSP-SAS, Spain -----2228

Nexteq PP-RTK Technology and System: L. Urquhart, Y. Zhang, J. Chen, S. Lee, Y. Gao, Nexteq Navigation, Canada -----2243

CRI Presents the CRI NAV 100: L. Stimac, D. Hartung, J. Suboski, Consolidated Resource Imaging -----2251

Real-Time Navigation System for Ultra-Tight Integration of GNSS and Multi-Sensors:
T. Li, J. Georgy, Z. Syed, C. Goodall, Trusted Positioning Inc., Canada -----2269

ARGUS: Assisting Personal Guidance System for People with Visual Impairment: O. Otaegui, Vicomtech-IK4, Spain; J. Seybold, TeleConsult Austria, Austria; J. Spiller, The 425 Company, UK; A. Marconi, CEIT Alanova, Austria; R. Olmedo, OK-Systems, Spain; M. Dubielzig, Siemens AG, Germany -----2276

Ultra-Low Power Host off-load GNSS Positioning: M. Torroja, S. Malkos, C. Verne, Broadcom Corporation -----2284

TERRASTAR – Precise Point Positioning Service for Land and Near Shore Applications:
G. Mack, D. McHardy, P. Toor, G. Wilcock, TERRASTAR, UK -----2292

Panel 4: High Integrity Systems

Wide Area Augmentation System (WAAS) – Program Update:	
D. Bunce, <i>Federal Aviation Administration</i>	-----2299
EGNOS V2 Program Update:	D. Thomas, <i>European Space Agency EGNOS Division, France</i>
	-----2327
MSAS Status:	T. Sakai, <i>Electronic Navigation Research Institute, Japan</i> ; H. Tashiro, <i>Civil Aviation Bureau, MLIT, Japan</i>
	-----2343
SDCM Development Strategy:	S. Karutin, <i>Russian Space Systems, Russia</i>
	-----2361
The Influence of the Ionosphere on SBAS:	T. Walter, <i>Stanford University</i>
	-----2373
Evolution of SBAS: Two Frequencies & Multiple Constellations:	T. Walter, <i>Stanford University</i>
	-----2394
ESA R&D Program GNSS Evolution Program Update:	F. Torán, <i>European Space Agency, France</i>
	-----2414

A5: GNSS and the Atmosphere 2

GNSS Bias Calibration Process and Results:	P. D'Angelo, J. Pulido, D. Rincón, <i>DEIMOS Space, Spain</i> ; P. Silva, P. Vieira, <i>DEIMOS Engenharia, Portugal</i> ; F. Amarillo, <i>ESA/ESTEC. TEC-ETN, The Netherlands</i>
	-----2440
Eliminating Potential Errors Caused by the Thin Shell Assumption: An Extended 3D UNB Ionospheric Modelling Technique:	W. Zhang, R.B. Langley, <i>University of New Brunswick, Canada</i> ; A. Komjathy, <i>University of New Brunswick, Canada & JPL/California Institute of Technology</i> ; S. Banville, <i>University of New Brunswick, & Natural Resources Canada</i>
	-----2447
Impact of Ionospheric Horizontal Asymmetry on Electron Density Profiles Derived by GNSS Radio Occultation:	M.M. Shaikh, R. Notarpietro, R. Romero, F. Dovis, <i>Politecnico di Torino, Italy</i>
	-----2463
Correlation Properties of a 2-D Array of High Latitude Scintillation Receivers:	G.S. Bust, <i>Johns Hopkins University APL</i> ; S. Datta-Barua, <i>Illinois Institute of Technology</i> ; K. Deshpande, <i>Virginia Polytechnic Institute and State University</i> ; S. Bourand, <i>Illinois Institute of Technology</i> ; S. Skone, <i>University of Calgary, Canada</i> ; Y. Su, <i>Illinois Institute of Technology</i>
	-----2470
Modeling the Effects of Ionospheric Scintillation on GPS Carrier Phase Tracking using High Rate TEC Data:	R. Tiwari, H.J. Strangeways, <i>Newcastle University, UK</i> ; S. Skone, <i>University of Calgary, Canada</i>
	-----2480
Improved Troposphere Blind Models Based on Numerical Weather Data:	G. Möller, R. Weber, J. Böhm, <i>Vienna University of Technology, Austria</i>
	-----2489
Benefit of Multi GNSS Processing with GPS, GLONASS, and QZSS for Tropospheric Monitoring:	T. Iwabuchi, C. Rocken, <i>GPS Solutions Inc. USA</i> ; A. Wada, M. Kanzaki, <i>Hitachi Zosen Corp., Japan</i>
	-----2496

GNSS Radio Occultation Technique and Space Weather Monitoring: X. Yue, W.S. Schreiner, Y-H. Kuo, D.C. Hunt, *University Corporation for Atmospheric Research*; C. Rocken, *GPS Solutions Inc.* -----2508

Comparative Ionosphere Electron Content Estimation Method in SBAS Performances: P. Alleau, G. Buscarlet, S. Trilles, M. Van Den Bossche, *Thales Alenia Space, France*; J. Bigot, *Institut Supérieur de l'Aéronautique et de l'Espace, France* -----2523

B5: Advances in Military GNSS Systems and Applications

Robust Open Service GNSS Receivers for Military Applications: G.A. McGraw, B. Disselkoen, *Rockwell Collins*; G. Buesnel, *Satellite Applications Catapult Ltd., UK* -----2533

Jamming Detection in GNSS Receivers: Performance Evaluation of Field Trials: E. Axell, F.M. Eköf, M. Alexandersson, P. Johansson, *Swedish Defense Research Agency, Sweden*; D.M. Akos, *Luleå University of Technology, Sweden* -----2542

Multi-Sensor, Signals of Opportunity Augmented GPS/GNSS Challenged Navigation: P. F. MacDoran, M.B. Mathews, *Loctrionix® Corporation*; K.L. Gold, *Emergent Space Technologies*; J.L. Alvarez, *Southwest Research Institute®* -----2552

Navigation-aiding using a 94GHz Radar for Helicopter Operations: J. McKitterick, T. Case, M. Elgersma, *Honeywell Aerospace Advanced Technology* -----2562

Interference-Resistant Vertically-Guided Approaches for Military Aircraft in Civil Airspace: D.A. Stratton, *Rockwell Collins, Inc.* -----2569

On-the-Fly Estimation of Antenna Induced Biases in SFAP Based GNSS Antenna Arrays: Y.C. Chuang, I.J. Gupta, *The Ohio State University* -----2577

Evaluating Integrity and Continuity Risks of Cycle Resolution in the Presence of Receiver Faults: S. Khanafseh, S. Langel, M. Joerger, B. Pervan, *Illinois Institute of Technology* -----2583

C5: Next Generation GNSS Integrity

GPS Integrity Architecture Opportunities: C.S. Miles, *Federal Aviation Administration*; K. Kovach, *The Aerospace Corporation*; J. Dobyne, *Booze Allen & Hamilton*; K. Van Dyke, *U.S. Department of Transportation*; M. Weiss, *National Institute of Standards and Technology* -----2592

Advanced RAIM System Architecture with a Long Latency Integrity Support Message: J. Blanch, T. Walter, P. Enge, *Stanford University* -----2605

An Analysis of ARAIM Performance Sensitivity to the Ground System Architecture Definition: C. Milner, C. Macabiau, C. Dulery, *Ecole Nationale de l'Aviation Civile, France*; M. Mabilleau, *Egis Avia, France*; N. Suard, C. Rodriguez, *CNES, France*; S. Pujol, *DSNA-DTI, France* -----2614

Advanced RAIM Architecture Design and User Algorithm Performance in a Real GPS, GLONASS and Galileo Scenario: I. Martini, M. Rippl, M. Meurer, <i>German Aerospace Center (DLR), Germany</i>	2624
The Impact of GPS Modernization on Standalone User Performance and Integrity with ARAIM: S. Pullen, P. Enge, <i>Stanford University</i> ; S. Shaw, C. Frey, J. Frye, M. Souder, <i>Lockheed Martin</i>	2637
Analysis of Multi-GNSS Service Performance Assessment: ARAIM vs. IBPL Performances Comparison: A. Cezón, M. Cueto, <i>GMV, Spain</i> ; I. Fernández, <i>European Commission</i>	2654
RAIM with Non-Gaussian Errors: P. Misra, J. Rife, <i>Tufts University</i>	2664
ESA's Multi-Constellation Regional System Land Users Test-Bed Integrity Algorithms Experimentation Results: E. Domínguez, J. Simón, <i>GMV, Spain</i> ; M. Seetzen, <i>CGI, UK</i> ; Y. Zheng, <i>NSL, UK</i> ; E. Wittmann, <i>IFEN GmbH, Germany</i> ; D. Lekaim, <i>Thales Alenia Space, France</i> ; M. Tossaint, M. Jeannot, <i>European Space Agency, The Netherland</i>	2672
Performance of Advanced RAIM When an Earth Orientation Parameter Fault Affects the Satellites in View One at a Time: Y.C. Lee, <i>The MITRE Corporation/CAASD</i>	2690
D5: GNSS Algorithms and Methods 1	
Integrity Risk and Continuity Risk for Fault Detection and Exclusion Using Solution Separation RAIM: M. Joerger, S. Stevanovic, F-C. Chan, S. Langel, B. Pervan, <i>Illinois Institute of Technology</i>	2702
A Novel Multipath Estimation and Tracking Algorithm for Urban GNSS Navigation Applications: N. Sokhanda, <i>University of Calgary, Canada</i>	2723
Offline Analysis of BeiDou MEO-3 Signal Quality: C-Y. He, J. Guo, X. Lu, X. Wang, <i>NTSC, Chinese Academy of Sciences, China</i>	2739
Multipath Mitigation by Voting Channel Impulse Response in Navigation Domain with High-sensitivity GNSS Receivers: Z. He, M. Petovello, <i>University of Calgary, Canada</i>	2749
Open GNSS Signal Authentication Based on the Galileo Commercial Service (CS): O. Pozzobon, C. Sarto, A. Pozzobon, <i>Qascom, Italy</i> ; D. Dötterböck, B. Eissfeller, <i>University FAF Munich, Germany</i> ; E. Pérez, D. Abia, <i>Acorde Technologies, S.A.</i>	2759
Federated Filtering Algorithm of Heading Angle Based On Magnetometer/GPS/IMU Integrated Navigation System: X. Chen, H. Guo, H. Yin, <i>Nanchang University, Nanchang China</i> ; M. Yu, <i>Jiangxi Normal University, China</i> ; J. Xiong, <i>Nanchang University, China</i>	2769
Subarray Selection for Adaptive Array Signal Processing in GNSS Applications: X. Wang, E. Abutianios <i>University of New South Wales, Australia</i> ; M. Trinkle, <i>University of Adelaide, Australia</i>	2776

Stability Criteria for GNSS Receiver Tracking Loops: P.W. Ward, *Navward GPS Consulting*; T.D. Fuchser, *Fuchser GPS Consulting* ----- 2786

A Modified Second-Order Extended Kalman Filter for Positioning: P. Lu, X. Liu, J. Yang, S. Yang, *Southeast University, China* ----- 2807

E5: Multi-Constellation/Portable Navigation Devices

BeiDou Integration in Cellphones and Tablets, Preferred Architecture for Consumer Products: F. van Diggelen, K.W. Tan, *Broadcom Corporation* ----- 2814

Statistical Characterization of BeiDou Navigation Errors with a Consumer Multi-Constellation GNSS Receiver: C-T. Weng, C-W. Chen, W-H. Ting, *MediaTek Inc., Taiwan* ----- 2821

Precision Limits of Low-Energy GNSS Receivers: K.M. Pesyna, Jr., R.W. Heath, Jr., T.E. Humphreys, *The University of Texas at Austin* ----- 2828

Single Chip Receiver for GNSS and LEO Constellations: J. Cookman, *CSR Technology, Inc.*; G. Gutt, D. Lawrence, *iKare Corporation* ----- 2835

Multi-constellation GNSS Receiver for Rail Applications: A. Ferrario, L. Marradi, P. Iacone, A. Galimberti, *Thales Alenia Space Italia, Italy* ----- 2840

An Insight on Mass Market Receivers Algorithms and their Performance with Galileo OS: N. Linty, *Politecnico di Torino, Italy*; P. Crosta, *European Space Agency, The Netherlands*; P.G. Mattos, *STMicroelectronics, UK*; F. Pisoni, *STMicroelectronics, Italy* ----- 2852

Techniques for 3D Misalignment Calculation for Portable Devices in Cycling Applications: H-W. Chang, *University of Calgary/Trusted Positioning Inc., Canada*; J. Georgy, *Trusted Positioning Inc., Canada*; N. El-Sheimy, *University of Calgary, Canada* ----- 2862

Beyond Where to How: A Machine Learning Approach for Sensing Mobility Contexts Using Smartphone Sensors: R.E. Guinness, *Tampere University of Technology, Finland* ----- 2868

F5: Interference and Spectrum Issues 1

Proving Location Using GPS Location Signatures: Why it is Needed and A Way to Do It: L. Scott, *LS Consulting* ----- 2880

Signal Acquisition and Tracking of Chirp-Style GPS Jammers: R.H. Mitch, M.L. Psiaki, S.P. Powell, B.W. O'Hanlon, *Cornell University* ----- 2893

A Novel Detection and Tracking Algorithm of Chirp Type Civilian GNSS Interference: C.H. Kang, S.Y. Kim, C.G. Park, *Seoul National University, Republic of Korea* ----- 2910

A Civil GPS Anti-Spoofing and Recovering Method Using Multiple Tracking Loops and an Adaptive Filter Technique: G.B. Moon, *Konkuk University, South Korea*; S-H. Im, *Korea Aerospace Research Institute, South Korea*; G-I. Jee, *Konkuk University, South Korea* ----- 2916

Spoof Detection Using Multiple COTS Receivers in Safety Critical Applications:	P.F. Swaszek, <i>University of Rhode Island</i> ; R.J. Hartnett, <i>U.S. Coast Guard Academy</i>	-----	2921
GNSS Spoofing Detection Based on a Sequence of RSS Measurements:	V. Dehghanian, <i>Mount Royal University, Canada</i> ; J. Nielsen, <i>University of Calgary, Canada</i>	-----	2931
Autonomous Spoofing Detection and Mitigation in a GNSS Receiver with an Adaptive Antenna Array:	A. Konovaltsev, M. Cuntz, C. Haettich, <i>German Aerospace Center (DLR), Germany</i> ; M. Meurer, <i>German Aerospace Center (DLR), Germany / RWTH Aachen University, Germany</i>	-----	2937
GNSS Spoofing Detection using High-Frequency Antenna Motion and Carrier-Phase Data:	M.L. Psiaki, S.P. Powell, B.W. O'Hanlon, <i>Cornell University</i>	-----	2949
PROSPA: Open Service Authentication:	M. Turner, A. Chambers, E. Mak, <i>Astrium UK</i> ; L.E. Aguado, B. Wales, M. Dumville, <i>NSL, UK</i>	-----	2992
GNSS Spoofing Detection Based on Particle Filtering:	J. Nielsen, <i>University of Calgary, Canada</i> ; V. Dehghanian, <i>Mount Royal University, Canada</i> ; N. Dawar, <i>University of Calgary, Canada</i>	-----	2997

Panel 5: Emerging GNSS

iGMAS and its Progress:	X. Dong, <i>CSNO, China</i>	-----	3006
Application of BeiDou in Civil Aviation:	X. Rui, <i>National Key Laboratory of CNS/ATM, China</i>	-----	3030
Galileo IOV Status and Results:	R. Lucas Rodriguez, <i>European Space Agency, The Netherlands</i>	-----	3065
SAR/Galileo: The GALILEO Search and Rescue Service:	I. Stojkovic, R. Morgan-Owen, <i>GALILEO Project Office – ESA/ESTEC, The Netherlands</i>	-----	3094
Galileo System Update and “Early Services:”	M. Lisi, <i>European Space Agency/European Commission/European GNSS Agency, The Netherlands</i>	-----	3125
European GNSS Evolution Program (EGEP):	S. Wallner, <i>European Space Agency, The Netherlands</i>	-----	3142

A6: Geodesy, Surveying and RTK for Civil Applications

GNSS Synthetic Aperture Processing with Artificial Antenna Motion:	T. Pany, N. Falk, B. Riedl, C. Stöber, J. Winkel, <i>IFEN GmbH, Germany</i> ; H.-P. Ranner, <i>Austrian Academy of Sciences</i>	-----	3163
Network RTK Computing in the Cloud and the Importance of using GLONASS and QZSS:	Z. Lukes, C. Rocken, L. Mervart, T. Iwabuchi, J. Barron, S. Cummins, <i>GPS Solutions Inc., USA</i> ; M. Kanzaki, <i>Hitachi Zosen Corp, Japan</i> ; L. Mullen, <i>Compass Informatics Ltd., Ireland</i>	-----	3172
Comparison of Methods for Determination of the Vertical Acceleration in Airborne Gravimetry Using LaCoste & Romberg Zero Length Spring Gravimeter:	D. Zhong, R. Kingdon, <i>CGG Canada Services Ltd., Canada</i>	-----	3180

Assessment of Multi-constellation RTK Solutions During Differential Correction Data Outages: V. Bhandari, K. O'Keefe, G. Lachapelle, <i>University of Calgary, Canada</i>	3194
Augmenting GPS RTK with Regional BeiDou in North America: J. Dou, K. O'keefe, <i>University of Calgary, Canada</i>	3205
New Systems, New Signals, New Positions – Providing BeiDou Integration: P. Fairhurst, X. Luo, A. Aponte, <i>Leica Geosystems AG, Switzerland</i>	3214

B6: Standalone GNSS Services in Challenging Environments

Investigation of Multipath Mitigation Methods for High Precision GNSS Applications: A. Broumandan, Y. Zhang, A. Schultz, <i>Nexteq Navigation, Canada</i>	3221
A Portfolio Approach to NLOS and Multipath Mitigation in Dense Urban Areas: P.D. Groves, Z. Jiang, M. Rudi, P. Strode, <i>University College London, UK</i>	3231
GNSS Receiver Carrier Tracking Loop Impact on Ionosphere Scintillation Signal C/N₀ and Carrier Phase Estimation: X. Mao, <i>Samsung Semiconductor Inc.</i> ; Y. Morton, <i>Miami University (Ohio)</i>	3248
Robust Receiver Design for Equatorial Regions During Solar Maximum: M. Najmafshar, F. Ghafoori, S. Skone, <i>University of Calgary, Canada</i>	3255
Integration of Vector Tracking Loop and Multipath Mitigation Technique and its Assessment: L-T. Hsu, <i>National Cheng Kung University, Taiwan</i>	3263
Detection of Correlation Distortions Through Application of Statistical Methods: M. Pini, B. Motella, M. Troglia Gamba, <i>Istituto Superiore Mario Boella, Italy</i>	3279
Mitigation of CW PPDs via Signal Tracking Suppression: T. Kraus, B. Eissfeller, <i>Universität der Bundeswehr München, Germany</i>	3290
Characterization of Time to First Fix for Standalone and Aided GNSS Multi-constellation Receivers in Challenging Environments: T. Ferreira, F. Pelica, R. Sarnadas, L. Bonardi, <i>GMV, Portugal</i> ; P. Crosta, R. Prieto-Cerdeira, <i>European Space Agency</i>	3295

C6: Space Applications

Navigating Above the GPS Constellation – Preliminary Results from the SGR-GEO on GIOVE-A: M. Unwin, R. De Vos Van Steenwijk, P. Blunt, Y. Hashida, <i>Surrey Satellite Technology Ltd., UK</i> ; S. Kowaltschek, L. Nowak, <i>European Space Agency</i>	3305
Flight Results of the NOX Dual-frequency GPS Receiver Payload On-board the TET Satellite: A. Hauschild, M. Markgraf, O. Montenbruck, <i>German Space Operations Center (DLR/GSOC), Germany</i>	3316
Navigation Performance of Global Navigation Satellite Systems in the Space Service Volume: D.A. Force, <i>NASA Glenn Research Center</i>	3325
GPS-Based Precise Relative Orbit Determination for LEO Satellites Using GPS Double-Differenced Carriers Phases: Z. Kang, B. Tapley, S. Bettadpur, P. Nagel, <i>The University of Texas at Austin</i>	3329

Leveraging the L1Composite Signal to Enable Autonomous Navigation at GEO and Beyond: S. Ramakrishnan, T. Reid, P. Enge, <i>Stanford University</i>	3336
GNSS-based Precise Orbit Determination for a Highly Eccentric Orbit in the STE-QUEST Mission: G. Hechenblaikner, J-J. Floch, F. Soualle, M-P. Hess, <i>EADS Astrium, Germany</i>	3347
Weak GNSS Signal Navigation to the Moon: P.F. Silva, H.D. Lopes, T.R. Peres, J.S. Silva, <i>DEIMOS Engenharia, Portugal</i> ; J. Ospina, F. Cichocki, <i>DEIMOS Space, Spain</i> ; F. Dovis, L. Musumeci, <i>Politecnico de Torino, Italy</i> ; D. Serant, T. Calmettes, I. Pessina, <i>Thales Alenia Space</i> ; J.V. Perelló, <i>European Space Agency</i>	3357
Performance Demonstration of NSPO Space-borne GPS Receiver: H-Y. Chang, H-C., Chang, C-T. Lin, <i>National Space Organization, Taiwan</i>	3368

D6: Interference and Spectrum Issues 2

Preparing for New Wireless Spectrum Policies, Is the GNSS Industry Ready?: R. Lee, <i>Greenwood Telecommunications Consultants LLC</i> ; J.D. Litton, <i>Litton Consulting Group, Inc.</i> ; P. Williams, <i>Consultant to GNSS, MSS Industries</i>	3378
An Interference Monitoring System for GNSS Reference Stations: J. Wendel, C. Kurzhals, <i>Astrium GmbH, Germany</i> ; M. Houdek, <i>Iguassu Software Systems a.s.</i> ; J. Samson, <i>European Space Agency, France</i>	3391
Joint Space-Time Interference Mitigation for Embedded Multi-Antenna GNSS Receivers: M.H. Castañeda, M. Stein, <i>Technical University Munich, Germany</i> ; F. Antreich, <i>German Aerospace Center DLR, Germany</i> ; E. Tasdemir, L. Kurz, T.G. Noll, <i>RWTH Aachen, Germany</i> ; J.A. Nossek, <i>Technical University Munich, Germany</i>	3399
Analysis of DME/TACAN Interference on the Lower L-Band: A. Steingass, <i>German Aerospace Center (DLR), Germany</i>	3409
Continuous Adaptive Interference Nulling for Defeat of Wideband GNSS Interference: R. Vosburgh, V. Haridasan, <i>Physical Devices LLC</i> ; C. Wilson, <i>North Carolina State University</i>	3417
Optimization of a Blind Adaptive Spatial Filter for Interference Mitigation in GNSS Receivers: E. Tasdemir, L. Kurz, T.G. Noll, <i>RWTH Aachen University, Germany</i>	3424
Overcoming RFI with High Mask Angle Antennas and Multiple GNSS Constellations: L. Heng, <i>University of Illinois at Urbana-Champaign</i> ; T. Walter, P. Enge, <i>Stanford University</i> ; G.X. Gao, <i>University of Illinois at Urbana-Champaign</i>	3433
The Karhunen-Loève Transform as a Future Instrument to Interference Mitigation: A. Szumski, B. Eissfeller, <i>University FAF Munich, Germany</i>	3443
QRD-based and SMI-based MVDR Beamforming for GNSS Software Receivers: L.T. Ong, B. Sarankumar, <i>Temasek Laboratories at National University of Singapore, Singapore</i>	3450

Transform Domain Interference Suppression in GPS/BD-2 Receiver Based on Fractional Fourier Transform: Y. Zhang, *University of Calgary, Canada*; H. Wu, *Beijing Microelectronics Technology Institute, China*; Y. Gao, *University of Calgary, Canada* -----3456

E6: Clock/Timing and Scientific Applications

Performance Analysis of Micro/Nano Scale Oscillators in GPS Receiver Applications: S.K. Kalyanaraman, J.A. Lovseth, A.J. Reichenauer, *Rockwell Collins*; J. Rogers, *Defense Advanced Research Projects Agency (DARPA)* -----3464

A Pilot Experiment for GPS Link Calibration Between TL-MSL: J-L. Wang, Y-J. Huang, H-T. Lin, C-S. Liao, S-Y. Lin, *Chunghwa Telecom Co., Ltd., Taiwan*; T. Armstrong, *Measurement Standards Laboratory, New Zealand*; S-Y. Huang, *National Tsing Hua University, Taiwan* -----3474

Investigating Natural Hazards Using GNSS Measurements: The Chelyabinsk Meteor Ionospheric Impact: Y-M. Yang, A. Komjathy, M. Butala, A.J. Mannucci, *NASA JPL, California Institute of Technology*; R.B. Langley, *University of New Brunswick, Canada*; J. Snively, M. Hickey, *Embry-Riddle Aeronautical University*; D. Galvan, *RAND Corporation*; J. Lee, *Korea Advanced Institute of Science and Technology, Republic of Korea* -----3480

Evaluating Aircraft Positioning Methods for Airborne Gravimetry: Results from GRAV-D's "Kinematic GPS Processing Challenge." T.M. Damiani, A. Bilich, G.L. Mader, *NOAA- National Geodetic Survey* -----3489

Joint Positioning and Time Synchronization for APNT: M. Suess, B. Belabbas, M. Meurer, *German Aerospace Center (DLR), Germany* -----3508

A Feasible Clock Control and Synchronization Method Used in CAPS Master Station: W. Jing, X. Lu, J. Wang, D. Zhao, C. He, Y. Rao, *National Time Service Center, Chinese Academy of Sciences, China* -----3516

F6: GNSS Algorithms and Methods 2

Optimal Doppler-Aided Autonomous Position with a Flexible Smoothing Window Width: X. Liu, S. Yang, J. Yang, P. Lu, *Southeast University, China* -----3521

A New Proposal for a FLL Discriminator Based on Energy: X. Tang, *Politecnico di Torino, Italy*; E. Falletti, *Istituto Superiore Mario Boella, Italy*; L. Lo Presti, *Politecnico di Torino, Italy* -----3528

A Robust Technique for Unambiguous BOC Tracking: J. Wendel, F.M. Schubert, *Astrium GmbH, Germany*; S. Hager, *Technical University Munich, Germany* -----3536

Design of an Adaptive Vector-tracking Loop for Reliable Positioning in Harsh Environment: S.F. Syed Dardin, V. Calmettes, B. Priot, *Université de Toulouse, ISAE, France*; J-Y. Tourneret, *Université de Toulouse, IRIT-ENSEEIHT, France* -----3548

New Algorithm for GNSS Positioning Using System of Linear Equations: B. Oszczak, *University of Warmia and Mazury and Air Force Academy, Poland* -----3560

Indoor Multipath Characterization and Separation using Distortions in GPS Receiver Correlation	-----	3564
Peaks: V. Bellad, M.G. Petovello, <i>University of Calgary, Canada</i>		
Interference Detection Based on Time-Frequency Analysis for GNSS: K. Sun, W. Liu, H. Xu, <i>Hefei University of Technology, China; D. Yang, Beihang University, China</i>	-----	3577
Trade-off Analysis of Robust Carrier Phase Tracking Techniques in Challenging Environments: R. Sarnadas, T. Ferreira, <i>GMV, Portugal; J. Vilà-Valls, G. Seco-Granados, J.A. López-Salcedo; UAB; F.D. Nunes, F.M. G. Sousa: IT, Portugal; P. Crosta, F. Zanier, R. Prieto-Cerdeira, European Space Agency</i>	-----	3586
Determination of Early-Late Discriminator Errors on Filtered BPSK Waveforms: B. Fonville, E. Powers, D. Matsakis, <i>U.S. Naval Observatory</i>	-----	3600
Parallel Acquisition of GNSS Signal Based on Combined Code: L. Xu, K. Chen, R. Ying, P. Liu, W. Yu, <i>Shanghai Jiao Tong University, China</i>	-----	3607

Panel 6: Unmanned Vehicles

Multi-Sensor Fusion for Navigation of Autonomous Vehicles: A. Soloviev, <i>Qunav</i>	-----	3615
Unmanned Systems (Robotics): Challenges and Opportunities: D. Gebre-Egziabher, <i>University of Minnesota</i>	-----	3633